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THE PROPAGATION AND CULTURE OF THE PISTACHIO NUT

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INTRODUCTION

The pistachio nut, Pistacia vera L., is the only nut of some twelve or more species of Pistacia that attains sufficient size to satisfy consumer requirements for an edible nut. In the native habitat of each species, the smaller kernels of Pistacia mutica, Fisch. and Mey., Pistacia terebinthus L. and Pistacia atlantica, Desf. are sometimes eaten but are considered more useful as a source of vegetable oil. The color of the kernel of the pistachio nut ranges from light yellow to deep green throughout; the quality from a dry, woody to a rich, oily nut-like flavor.

One of the earliest of the pistachio plantings in this country was made at Fresno, California, some 65 or 70 years ago. The seedling trees in this planting were grown from seed introduced from the Mediterranean area. The nuts harvested from these trees, although variable in size, were, for the most part, too small for commercial use. The parent trees were undoubtedly of hybrid origin since it is common practice in some Mediterranean countries to graft pistachio varieties on the wild P. terebinthus trees, leaving an occasional Terebinth male to act as a pollenizer. Thus few, if any, additional seedling plantings were made.

In the early 1900's the Plant Introduction Section of the U. S. Department of Agriculture introduced for evaluation and test a few named pistachio nut varieties. Scions of the Bronte and Trabonella were obtained from Sicily, and Sfax from Tunisia. These, together with the Red Aleppo variety were tested at the U. S. Plant Introduction Station at Chico, California. Distribution of these varieties to interested growers in Arizona, California, Nevada and Utah followed their test at Chico. Small plantings of one or more of these varieties are still to be found growing in the Sacramento and San Joaquin valleys of California, the largest being the Philibosian orchard at Elk Grove, which contains a considerable number of 45-year-old trees of the Red Aleppo and Trabonella varieties topworked on P. atlantica seedlings.

Initial interest in planting these pistachio nut varieties soon subsided. Subsequent plantings have been relatively few in number due, no doubt, to losses experienced in transplanting the trees from nursery to orchard, which are higher than is normally the case in transplanting trees of other nut crops. Materially reduced yields due to inadequate knowledge of pollination requirements and a similar lack of information on methods to employ in preparing the nuts for

market have also been contributing factors. The Station's studies of these transplanting, pollination and harvesting problems have supplied answers to the first two of these and, given time, should yield sufficient information on after harvest handling of the fruits to enable the growers to remove the soft, external epicarp, eliminate nuts with undeveloped kernels (empties) and separate those with unsplit shells from those whose shells are split. The split-shelled nuts are in demand in the unshelled, salted nut trade.

During the last 40 years, the Plant Introduction Section of the U. S. Department of Agriculture has built up a collection of Pistacia species and pistachio nut varieties at its Chico Plant Introduction Station. Real emphasis was given to the introduction and study of this nut in the early 1930's. In 1929, W. E. Whitehouse, one of the Section's plant explorers, visited Russian Turkestan, Iran and other nearby areas, collecting seed, scions and cultural information. The wild and cultivated pistachio nut strains brought back were established at the U. S. Plant Introduction Garden at Chico, California, and these, together with the small collection of varieties already available, made possible the initiation of intensive cultural studies in 1935. These studies, while far from complete, have progressed sufficiently to permit publication of some phases of the work now in progress. The pertinent information, both published and unpublished, which has resulted from the last twenty years' evaluation of this nut has been incorporated in this publication.

CENTERS OF PRODUCTION

Pistachio nuts are grown on a commercial scale principally in Turkey, Iran, Afghanistan, Italy and Syria, with lesser amounts produced in India, Lebanon, Pakistan and Tunisia. Import records of the United States government show that for the period of 1946 to 1952 Turkey exported to this country a total of 8032 tons and that 3630, 1390, 1380 and 958 tons, respectively, were exported by Iran, Afghanistan, Italy and Syria. The greater part of these nuts was marketed unshelled and salted, and importers claim that each year they could process and sell this entire five year importation of approximately 15,000 tons, if the nuts were available. Thus far, only a small quantity are produced commercially in California.

CLIMATIC REQUIREMENTS

The pistachio nut thrives best in areas having cool enough winters for properly breaking bud dormancy and long, hot, dry summers for maturing the nuts. In Iran, for example, the best pistachio nut orchards are grown at an elevation of 4,000 feet on the extensive plateau which makes up the heart of that country, and which is reputed to be one of the worst deserts in the world. Rainfall averages 10 to 15 inches a year, and in the south and east is less than five inches. Summer temperatures reach 100° F. during the day, but the nights are cool and winter temperatures frequently drop to 0° F. in the northern portion of this plateau. The acreage planted to this nut in Iran and Turkey has increased considerably

over the past ten or fifteen years.

In general, areas adapted to almonds and olives appear to be suitable. In the United States favorable environmental conditions are found in the San Joaquin and Sacramento Valleys of California and other similar areas. The pistachio nut is produced satisfactorily as far south as Bakersfield, but beyond there, particularly around Los Angeles, production is irregular, the trees bearing well only after fairly cold winters or at altitudes sufficiently high to provide similar winter temperatures.

At Indio, California, the edible pistachio nut cannot be grown, but an ornamental form, P. atlantica, which is indigenous to North Africa, does well. At Sacaton, Arizona, a crop of nuts is borne only one year out of five on the average, for in most years there is not quite enough cold weather to break bud dormancy and delayed foliation occurs. Little is known about the northern limits of growth, although it is believed that in areas with a shorter growing season than the Sacramento Valley it might be difficult to mature and harvest the crop, especially where the fall rains and cool weather start in September.

SOURCE OF TREES

Even though there is considerable demand, nurserymen are reluctant to grow pistachio trees for sale because of high losses encountered when they are handled as bare-rooted trees. Growing in cans is costly and is apt to produce a "pot bound" root system which usually stunts the growth of the tree when it is planted in the orchard. As a result it is advisable for growers to not only produce their own rootstocks but to topwork them later to suitable varieties.

ROOTSTOCKS

Seedlings of several Pistacia species are used as rootstocks, P. atlantica and P. terebinthus (P.I. 8521)* being two that have been tested and recommended by the Plant Introduction Section of the Agricultural Service, U.S.D.A. While seedlings of these two species make a slower growth in the nursery than do those of P. vera or its hybrids with other species, they are more nematode resistant than P. vera seedlings. In addition, it is becoming evident as a result of studies at the Chico Station that pistachio nut varieties budded on these two species overtake and are superior in growth and yield to those budded on P. vera. Seedlings of the ornamental P. chinensis Bunge have also been tested as a rootstock, but have not been recommended. When pistachio nut varieties are budded on P. chinensis there is a tendency for the former to make a heavy overgrowth at the bud union, especially when its position is just above or slightly below ground level.

PROPAGATION

Pistacia species seeds are collected in the fall, cleaned and stored dry at approximately 70° F. until time to plant. Removal of the soft, external epicarp is accomplished by soaking the fruits in water for a few hours,

*Possible hybrid

then rubbing and washing them on a course screen. This soft portion must be removed before planting since it acts as a germination inhibitor. The cleaned seeds should be dried rapidly to avoid danger of molding, preferably at temperatures below 100° F.

Pistacia species seed can be planted in the nursery row from late fall to early spring. Seeds of P. atlantica can be planted without any pregermination treatment, although soaking in water for a few hours sometimes aids germination. This pregermination soaking is usually more beneficial if planting is delayed beyond late March. Seeds of P.terebinthus tend to be more variable than P.atlantica in their germination response for reasons not yet explainable. They do not require pregermination treatment if planted during the fall and winter. If planting is delayed until late March or April a more favorable response is usually obtained by soaking these seeds in water several hours, draining and holding them damp for two to three weeks at room temperature (about 70° F.) or until they begin to show signs of germination. This dampness can be retained by holding the seeds in some non-porous container, such as a polyethylene bag. Washing the seeds thoroughly in running water will generally wash off and control any excessive mold that may form on them during this pregermination treatment.

It is important that the soil be kept damp and free from crusting throughout the germination period. Mulching the seed row is both desirable and beneficial. Almost any material can be used that provides cover, such as sawdust, leaf-mold, sand, black polyethylene covering or even newspapers. Should either of the latter two materials be used, care must be taken to make sure an opening to the sun is provided as soon as the young seedlings appear above ground.

For those who may wish to grow and fruit out P. vera seedlings, an effective method is to soak the seed in water in a refrigerator (approximately 40°F.) for two weeks prior to planting. This treatment speeds up the germination process for seeds of this species, - - thus germination is completed in a shorter time. Approximately one half of the resultant seedlings will be females. P. chinensis seeds, like P. atlantica, can be sown without any pregermination treatment other than removal of the hull and a short soaking in water.

With early planting of seed, good care in watering and an ample supply of nutrients throughout the summer, part or all of the more vigorous seedlings may reach budding size by fall. The first two or three months are critical in the life of the seedling, and though a good moisture supply is essential at all times, care must be exercised to make sure they are not overwatered lest damping-off and "wet feet" problems develop. Should there be sudden blackening and death of some seedlings from injury in the crown or roots, withhold water for awhile, letting the surface soil dry and aerate. Before resuming the watering in such instances it would be advisable to mound the soil beside each row so that free water can be kept away from the crowns of the young plants. In the early stages thrips sometimes become quite active around the terminal growth of each seedling

causing malformation of the young leaves and dwarfing of the plant. These tiny insects can be easily controlled by an application of DDT or other insecticide.

Propagation of the pistachio nut is usually done by T-budding, placing two buds on each stock to insure a set of at least one. Budding may be carried out over a considerable period of time, but if started before mid-April, when sap flow is more apt to be excessive, a light set of buds may be expected. A marked improvement in bud-take occurs as the time of budding is extended through the summer and fall until the bark on the rootstocks starts tightening. Buds of both female and male P. vera varieties are quite large and require a fairly large seedling to accommodate them so that seldom are all rootstock seedlings of sufficient size to bud during the first season's growth.

TRANSPLANTING TO THE ORCHARD

Pistacia species seedlings tend to be taprooted in the nursery and suffer considerable transplanting shock their first season in the field. Consequently, they should be transplanted to their permanent planting site as early as possible. They grow well once they have become established.

Transplanting can be done any time during the dormant season, the sooner after leaf-fall in December or January the better. Likewise, planting as quickly as possible after lifting is essential. Pistacia roots are injured if exposed to the air for more than a few hours even though kept well dampened. All bare-rooted trees that cannot be planted at once should be heeled-in and the roots completely covered with soil until planting time. Thorough watering of each tree following transplanting will help reduce losses by compacting the soil around the roots. Seedlings that have reached sufficient size the first season in the nursery and have been budded can also be transplanted at this time. If the dormant variety buds fail to grow following transplanting, the seedling can be topbudded higher up on its trunk as soon as it has made sufficient new growth to take additional buds. Varieties propagated on well established seedlings in the orchard soon catch up in growth with those propagated in the nursery prior to transplanting.

In selecting rootstock seedlings for transplanting only the top 60 to 75 percent should be used. This amount varies from year to year but in any case the small, runty ones that produce poor quality trees in the orchard should be discarded. Rootstocks have been grown in place by planting a few seed at each permanent location, selecting from among them the best seedling growing at each site. Although this method avoids problems in transplanting, it does entail the distribution of water to each planting site throughout the dry season rather than to a relatively concentrated location, such as a nursery or one's garden. Protective measures employed to prevent the drying out of nursery beds are applicable in this case.

Any of the several planting systems used for other tree crops can likewise be used in setting out the pistachio orchard. The square system

has equal distance between rows and trees within the row. The quincunx system has a fifth tree planted in the center of each square. The hexagonal or equilateral triangle system places the rows closer together but preserves the same distance between the trees. In any case the minimum distance for pistachio trees in a permanent planting should be not less than 30 feet between trees. A distance of 32 to 35 feet would be even better. Closer spacing, using fillers, can be used until crowding requires their removal.

EARLY GROWTH AND TRAINING

Pistachio trees are long lived and relatively slow growers as compared with other deciduous fruit trees. Since they do not make too dense a top there is little need for more than light pruning during the early development of the tree if it is properly trained. The maximum top and root growth that results insures earlier bearing.

When budded close to the ground and the bud is allowed to grow with little or no pruning or training, P. vera forms a medium-sized, bushy tree which hugs the ground. For the grower who is not concerned about cultivating under his trees this may be satisfactory providing the lateral scaffold branches do not originate so close together that they press upon one another as the tree matures. If this occurs, there can be splitting out at the trunk because of the pressures that develop. Destruction of trees by splitting out just as they reach good bearing age represents a serious loss to the grower.

While it is possible that in some instances a bush form of tree may be desirable, the high headed type lends itself to more efficient orchard operation, both in cultivation and in harvesting. In the case of the high headed tree the problem is one of early training for apparently little is needed otherwise, at least not until after the tree reaches bearing age and matures so that growth slows down. A modified leader type of training produces a tree whose lateral branches, when well spaced along the trunk, are capable of bearing heavy crops without breaking.

In its formative stages the pistachio nut tree produces a moderate number of long, upright branches that tend to become pendulant apparently because of lack of sufficient lignification. This pendulant type of growth is a pecularity of the pistachio tree that must be taken into account throughout the early training period. During the first year or so in the orchard, young trees of most varieties require staking to keep them upright. Bracing the long weak scaffold limbs in position with lath or some similar support, until they are thoroughly lignified, assists materially in forming a well shaped tree and does away with pruning back misshapen branches. High heading also provides somewhat for the pendulant growth and does away with the necessity of cutting off larger branches just as the tree reaches bearing age.

Pruning cuts on pistachio nut trees should be confined to branches of small diameter. Wounds two inches or more across tend to heal over

slowly, thus providing a ready entrance into the exposed wood for decay organisms. On large wounds there is a tendency for death of bark tissues around and below the cut. Unlike other fruit trees, when the food supply of tissues surrounding a branch is cut off by loss of the sustaining branch, apparently these tissues are not always able to obtain new food supplies rapidly from nearby sources. Painting the exposed wounds immediately with one of the commercial non-toxic asphalt emulsions is not only helpful in reducing decay but appears to be helpful to the healing process.

PRUNING BEARING TREES

Observations of the growth and bearing habits of experimental plantings of pistachio nut at the Chico Station, which have now reached their fifteenth year, suggest that lack of pruning may be detrimental to efficient production. As the trees reach bearing age and the more or less pendulant limbs are pulled downward and closer together by the weight of the crops, there is a tendency to fill in the gaps with new growth. With each addition of new growth more and more of the fruiting wood in the shaded inner areas gradually dies; the nut bearing region is thus gradually confined to the more exposed outer area of the tree. Since pistachio trees, like peaches, produce their flower buds on current year growths, a light thin-wood type of pruning should be initiated as needed, keeping in mind the fact that only enough small diameter cuts should be made to let in light and stimulate the production of good fruiting wood throughout the tree.

IRRIGATION

Under the usual summer drought conditions prevalent at Chico, leaves on unirrigated pistachio nut trees usually turn yellow and begin to drop off in August. When given an irrigation in July the leaves usually remain green and are retained until time for leaf fall in November. In an area with 18 or more inches of winter rainfall, at least two summer irrigations are necessary to maintain good tree growth.

In drier areas additional irrigations will be necessary for good tree performance; the response of the pistachio nut to good management practices is similar to that of other nut crops. Pistachio trees, like almonds, are sensitive to wet feet and any system of intercropping should avoid excessive use of water around the trees. Mounding or ridging about each tree will aid in keeping standing water away from the crowns during irrigation.

FERTILIZATION

Little is known about the nutritional requirements of pistachio trees other than that they respond to applications of nitrogen the same as most other trees. Nutritional studies now in the planning stage will supply information on the benefits to be derived from applications of potassium, phosphorus and other elements.

VARIETIES

None of the earlier introduced varieties have measured up to the requirements for a good commercial pistachio nut variety for this country, where higher production costs emphasize the need of high yielding, high shell

splitting, larger kerneled types. In some years the crop on some varieties has been seriously reduced by late frost injury to flower clusters. Of the earlier varieties introduced and tested at Chico, the Red Aleppo and Trabonella have been the most promising from the standpoint of quality and green kernel color. Yields over a period of years, while fairly good, have not been sufficient to recommend them for commercial planting nor has splitting of the shells of these varieties been high enough.

The program for the development of better varieties, which became one of the Plant Introduction Section's objectives in 1929, has yielded several seedling selections of promise. Three of these, Kerman, Damghan and Lassen, have been undergoing an evaluation since 1940 and have shown sufficient promise, both from the standpoint of blooming late enough to escape spring frosts and that of tree performance, to recommend extending their tests into other areas of California suitable to the growth of this nut. All three bear nuts that, as a rule, are larger and higher in shell splitting than any of the other varieties tested thus far at Chico.

In some years a portion of the Kerman nuts have an undeveloped third shell section, a sort of flap, which as a rule falls off during harvest or processing, exposing the kernel more than is usual when the shell consists of two equally developed parts. Processors have assured us that this characteristic does not lessen its acceptability as a commercial nut for their unshelled, salted nut trade. Lassen and Damghan nuts have not exhibited this trait.

POLLINATION

The pistachio nut tree is dioecious; that is, male and female flowers are borne on separate trees. It is also wind pollinated. Thus, pollinator trees must be so spaced throughout the orchard that they take advantage of the prevailing winds at flowering time in early April. Consequently male pollinators must be selected that will shed their pollen at the time the female blossoms are receptive. In the past, one male to each ten females has been the recommended ratio, but currently it is believed this can be increased to twelve females for each pollinator. Topworking a limb of a variety to a male scion instead of planting a male tree, while feasible, is not recommended because of the tendency of the non-bearing male limbs to outgrow the rest of the tree. Pollen of any of the Pistacia species will produce a good set of nuts when used to pollinate pistachio varieties. Of the pollinators studied, Chico No. 23 and Peters have proven satisfactory for the range of Red Aleppo and Trabonella bloom. Peters is suitable also for Kerman, Damghan and Lassen, varieties which tend to reach full bloom stage several days later than Red Aleppo and Trabonella. Peters serves as an excellent pollinator for the early part of their blossoming period, but to insure good pollination at all times, a male with a blooming period slightly later than Peters is needed. Of the several under study, one or two appear promising as supplemental pollinators to fill this gap.

BEARING HABIT AND YIELDS

The pistachio nut tree, like those of apple and some other fruits, is a biennial bearer, i.e., bears a heavy crop of nuts one year and little or none the next. The tree of this nut, as does the almond, bears a few

nuts 4 or 5 years after planting in the orchard, but does not begin to produce well until ten years of age. Fifteen-year-old pistachio nut trees, in experimental plantings at Chico, have produced several good crops. An average of the first five full crops will provide a fairly reliable estimate of what to expect in the way of crop yields during the first 20 years of a well cared for California orchard.

HARVESTING AND PREPARATION FOR MARKET

A great deal is yet to be learned about harvesting and handling the nuts. The fruit at maturity is a drupe. At Chico it matures in late August and September and occasionally in early October. At the time of maturity the external portion of the fruit changes from a light green to a pale, straw or whitish, opaque appearance, at the same time softening and loosening itself from the stony inner part of the ovary wall which is the gray-white inner shell. Thus it is easily slipped off by pressing between the fingers. Often the shell splits naturally along a longitudinal suture. Splitting of the shell facilitates the opening of the nuts by hand and is desirable from the consumers' point of view. Within the shell is found the one edible seed which contains an embryo that is composed of two large, flesh cotyledons, a small radicle and a small plumele. The cotyledons are different from those of most seeds in that they contain a green pigment.

The nuts hang well, so that, by leaving the crop on the tree until most of the nuts are ripe, the best nuts can be harvested at one time. As with almonds and walnuts, pistachio nuts can be knocked off the trees with poles or shaken onto canvas sheets and then sacked. They are not easily knocked off with rubber mallets as are almonds. If held in sacks over twenty-four hours, heating occurs, the soft external hull breaks down and spoils, and the shell and kernel become discolored. Drying can be accomplished on trays set out in the sun or in artificial driers. Rapid surface drying soon after hulling helps to prevent the development of surface molds.

Preliminary investigations of mechanical procedures which will make it possible to (1) remove the soft, external hull immediately after harvest (2) separate the empty nuts from those with well developed kernels and (3) separate the nuts with split shells from those whose shells are closed, have been initiated. Enough progress has been made to suggest that satisfactory removal of the hull by mechanical means will present no difficulty. Removing empty kerneled nuts, a number of which develop with or without pollination, will not be too difficult. The problem of separating the nuts with a split shell from those whose shell is closed appears to be the most difficult of solution, and is the one for which there must be an answer before the nuts can be economically prepared for the market.